

Resolving Discrepancies Between Air and Stream Temperature Warming Rates From Climate Change in Mountain Basins Using Dense Sensor Arrays and Air Microclimate Models

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Air temperature increases from global warming are expected to increase temperatures in the Earth's rivers and streams. Ongoing efforts to downscale climate models are improving the resolution at which air temperatures can be predicted, but outputs from the latest regional climate models remain coarse (e.g., 100s of km²) relative to the scales at which predictions are necessary for natural resource management in complex mountain terrain. Inexpensive digital sensors costing ~\$100/site facilitate collection of multi-year temperature data from many locations across a landscape and can be used to develop precise microclimate models with resolutions of 10s of square meters. We illustrate development and application of a microclimate model for the upper Boise River basin (7,000 km²), a mountainous area in central Idaho, to understand spatial and temporal variation in stream temperatures. From 2010 until the present, air temperatures have been recorded hourly at 60 sensor sites across the basin. These data were integrated with 4 km² gridded climatologies using mixed effects regression models to develop daily air temperature surface maps of 90 m² resolution. Predicted temperatures from the microclimate model were co-registered to stream temperatures measured at 34 stream sites during the same period. Air and stream temperature patterns were strongly correlated at most sites but important variability in these relationships also occurred relative to geomorphic context, seasonal period, and the time-step over which correlations were estimated. Detailed examination of these patterns promises to provide important insights regarding factors that cause variation in the thermal regimes of mountain streams. These insights could be incorporated to stream temperature models to make more accurate spatial predictions throughout river networks or understand responses to short-term weather patterns and long-term climate change.